

PRELIMINARY DATA SUMMARY

December 1991

U.S. Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
Field Research Facility
Duck, North Carolina

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CERC Field Research Facility
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

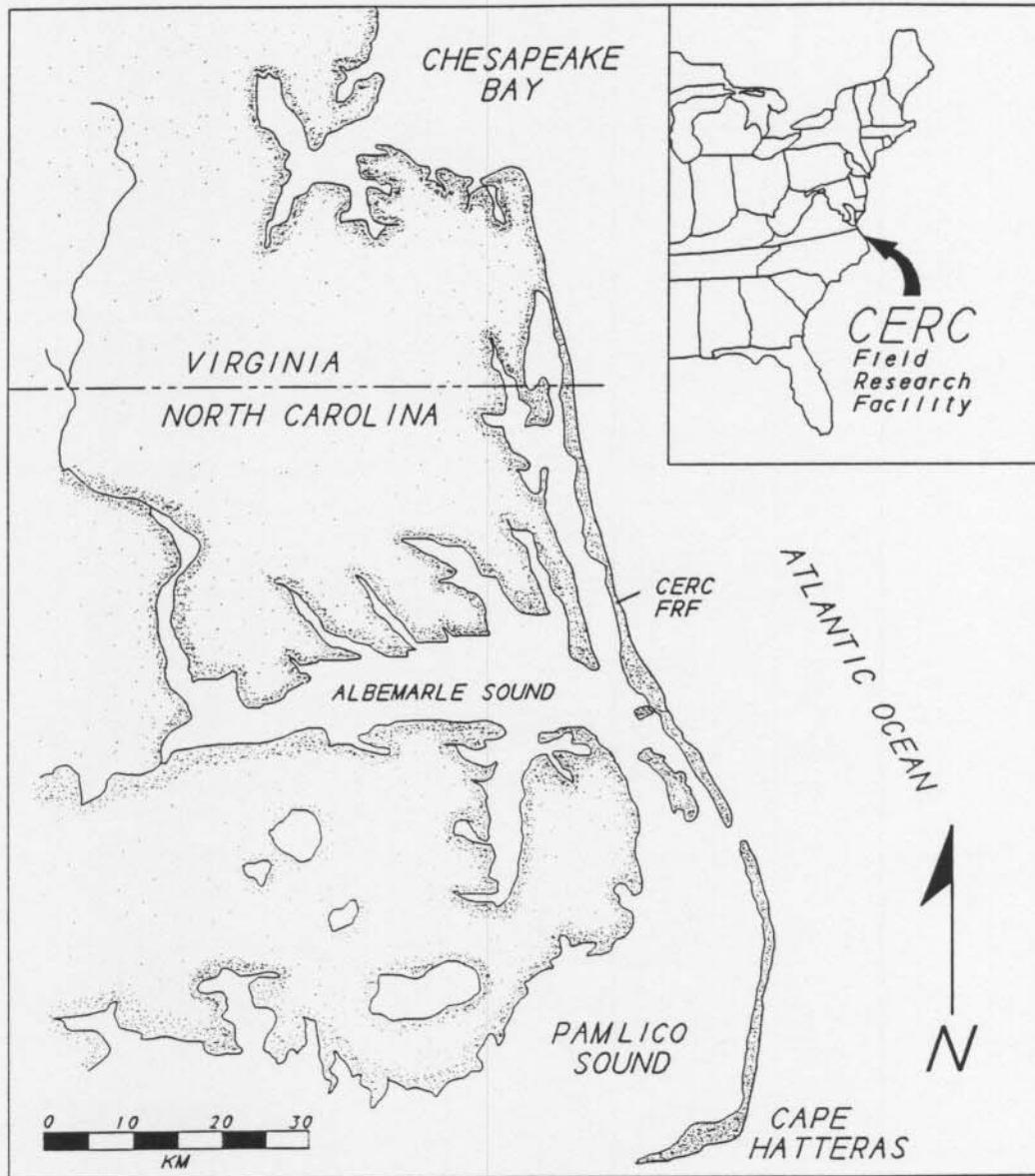


Figure 1. FRF Location Map

Table 1: Instrument Status/Data Availability

DEC 1991

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

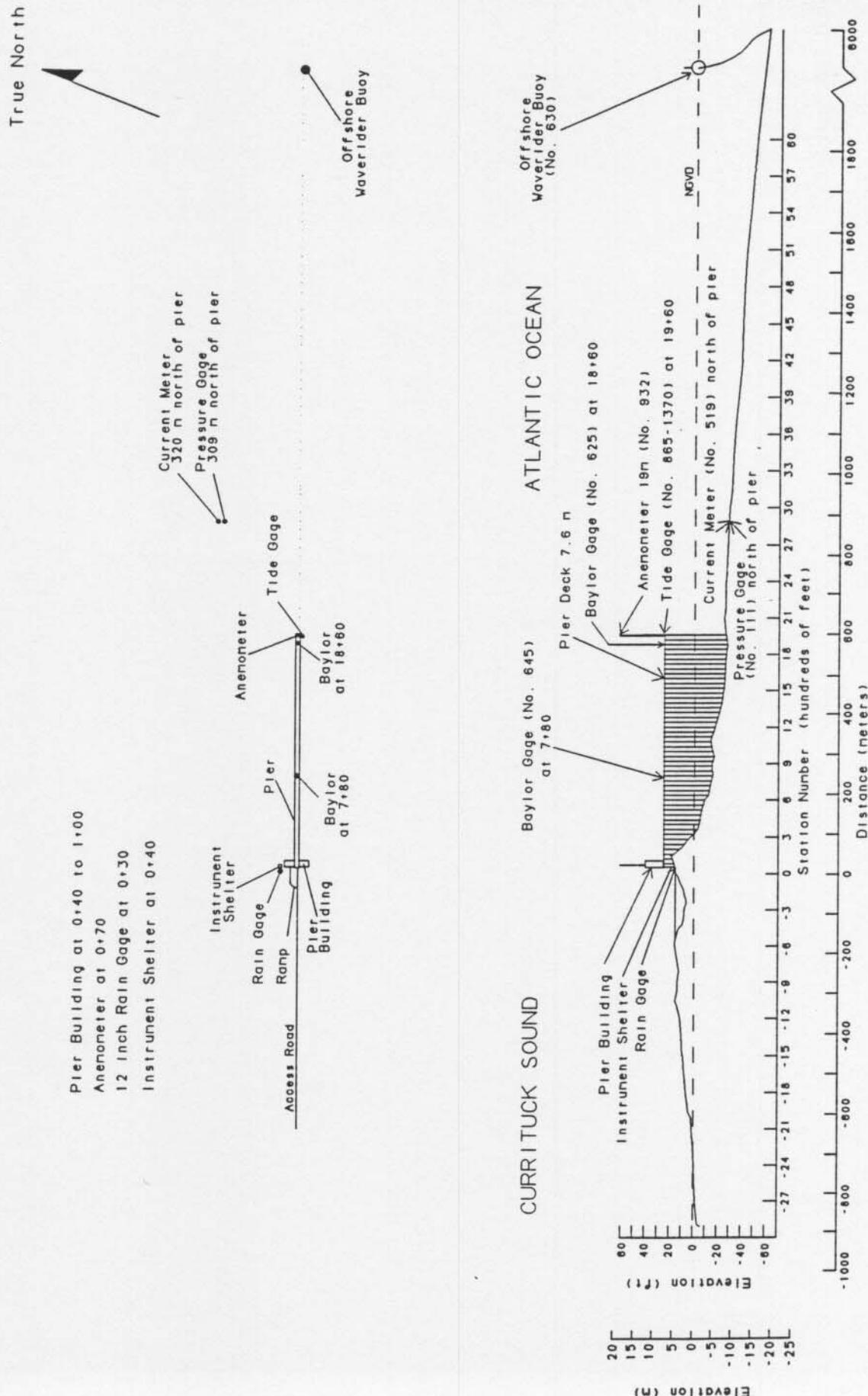


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $mm \times .03937 = in.$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $mb \times 0.02953 = in. Hg$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $m/s \times 1.943 = kn$

Table 2: Meteorological Data

Dec 1991

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
1	100	5	203	14.7	1020.9	0
	700	5	214	16.0	1020.6	0
	1300	9	209	22.6	1017.9	0
	1900	8	191	19.2	1016.9	0
2	100	8	214	18.9	1015.9	0
	700	6	224	18.3	1015.9	0
	1300	5	232	22.2	1014.5	0
	1900	5	170	18.6	1013.8	0
3	100	8	213	20.3	1011.8	0
	700	10	200	20.5	1008.1	0
	1300	10	202	22.3	1003.7	0
	1900	5	244	20.0	1002.6	0
4	100	8	282	16.8	1000.6	6
	700	8	285	8.0	1006.7	0
	1300	13	287	8.8	1009.1	0
	1900	10	298	3.9	1018.2	0
5	100	10	312	0.9	1023.0	0
	700	8	315	0.0	1027.0	0
	1300	6	337	4.4	1027.4	0
	1900	2	267	1.2	1027.0	0
6	100	5	222	4.5	1024.0	0
	700	8	240	5.2	1021.6	0
	1300	9	249	10.4	1018.9	0
	1900	3	269	7.5	1020.6	0
7	100	4	207	7.4	1020.9	0
	700	4	214	6.9	1020.6	0
	1300	6	238	13.2	1017.2	0
	1900	6	232	11.2	1017.2	0
8	100	4	253	9.7	1017.5	0
	700	5	230	8.8	1019.2	0
	1300	2	206	15.5	1018.6	0
	1900	5	209	13.2	1018.2	0
9	100	4	204	11.5	1016.5	0
	700	6	215	11.7	1015.5	0
	1300	5	250	17.6	1011.1	0
	1900	6	204	15.9	1009.1	0
10	100	8	249	17.3	1006.4	0
	700	12	343	10.4	1014.2	6
	1300	10	11	11.0	1018.6	0
	1900	6	42	9.8	1022.6	0
11	100	7	352	8.4	1023.0	0
	700	6	22	10.7	1024.3	0
	1300	5	6	12.9	1023.3	0
	1900	4	14	11.9	1024.0	0
12	100	2	353	9.1	1023.6	0
	700	5	53	12.7	1025.0	0
	1300	3	359	14.7	1023.3	0
	1900	3	104	12.7	1021.9	0
13	100	4	205	13.7	1020.9	0
	700	5	203	13.9	1020.6	0
	1300	7	215	20.7	1017.9	0
	1900	7	204	17.7	1017.2	0
14	100	7	211	16.0	1015.2	0
	700	6	221	15.5	1013.1	0
	1300	7	237	19.8	1008.7	0
	1900	6	261	16.0	1009.1	0
15	100	11	301	11.0	1015.9	0
	700	8	286	4.8	1020.9	0
	1300	5	286	8.6	1020.6	0
	1900	6	238	7.7	1020.3	0
16	100	8	254	6.8	1018.9	0
	700	10	315	3.0	1021.3	0
	1300	8	327	5.0	1022.6	0
	1900	3	306	2.1	1025.0	0

* electronic problems

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Dec 1991

Day	Hour	Wind Speed m/sec	Wind Direction deg TN	Temperature deg C	Atm Pressure mb	Precipitation mm
17	100	4	238	3.9	1024.3	0
	700	6	221	4.6	1024.0	0
	1300	9	211	11.6	1018.9	0
	1900	10	221	10.2	1016.5	0
18	100	8	240	9.0	1016.2	0
	700	4	276	6.8	1017.9	0
	1300	8	4	9.4	1017.5	0
	1900	14	4	6.0	1023.0	0
19	100	12	328	0.4	1027.4	0
	700	14	329	-1.8	1032.8	0
	1300	15	349	-0.3	1035.2	0
	1900	10	328	-0.2	1038.2	0
20	100	12	18	3.1	1037.9	0
	700	8	322	-0.1	1038.5	0
	1300	5	359	5.5	1036.8	0
	1900	3	254	1.8	1035.5	0
21	100	5	225	4.1	1030.1	0
	700	9	229	5.4	1024.3	0
	1300	9	255	8.8	1020.6	0
	1900	5	264	5.6	1019.9	0
22	100	5	310	4.2	1020.3	0
	700	8	5	6.6	1019.2	0
	1300	2	298	8.3	1017.5	0
	1900	4	208	4.7	1016.5	0
23	100	5	223	4.2	1013.5	0
	700	5	215	5.1	1011.1	0
	1300	6	209	16.4	1005.0	0
	1900	7	207	13.4	1003.3	0
24	100	6	234	12.4	1001.0	6
	700	13	26	9.7	1002.0	13
	1300	12	354	7.6	1008.1	4
	1900	5	322	4.6	1013.5	0
25	100	3	269	3.3	1016.2	0
	700	4	286	2.7	1020.6	0
	1300	3	24	7.7	1021.3	0
	1900	3	28	6.8	1024.3	0
26	100	5	44	7.0	1025.7	0
	700	4	45	6.9	1027.0	0
	1300	3	56	9.6	1026.0	0
	1900	4	80	9.2	1025.3	0
27	100	4	340	8.4	1024.3	0
	700	10	6	9.1	1026.3	0
	1300	8	36	8.4	1027.0	4
	1900	10	43	8.8	1028.7	0
28	100	9	49	9.8	1027.7	0
	700	9	44	10.2	1026.0	0
	1300	8	70	11.3	1022.3	0
	1900	8	91	12.5	1019.2	6
29	100	8	149	14.5	1014.2	16
	700	7	109	13.7	1008.4	31
	1300	5	258	15.6	1004.3	5
	1900	9	257	11.6	1005.4	0
30	100	9	253	9.5	1007.4	0
	700	6	292	7.7	1012.1	0
	1300	13	356	8.2	1015.9	0
	1900	13	13	7.7	1021.9	0
31	100	13	14	7.7	1024.7	0
	700	13	30	7.5	1027.4	0
	1300	11	29	8.6	1028.4	0
	1900	12	37	8.7	1029.4	0
		Resultant 3	293	Mean 9.8	Mean 1019.2	Total 97

* electronic problems

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PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all H_{mo} and T_p values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Dec 1991

Day	Hour	645		625		111		630	
		Baylor at 7+80 Hmo.m	T.sec	Baylor at 18+60 Hmo.m	T.sec	Pressure Gage Hmo.m	T.sec	Offshrd Hmo.m	Wvrdr T.sec
1	0100	0.54	4.92	0.47	8.00	0.53	8.26	0.70	4.74
	0700	0.24	4.66	0.52	8.53	0.55	8.00	0.67	8.00
	1300	0.30	5.02	0.52	8.00	0.57	8.26	0.77	8.26
	1900	0.34	6.92	0.59	7.76	0.60	6.74	0.91	8.00
2	0100	0.43	6.24	0.57	6.92	0.64	6.40	0.93	6.56
	0700	0.38	6.40	0.48	9.14	0.55	8.00	0.78	8.26
	1300	0.22	5.57	0.49	8.83	0.52	8.53	0.71	6.56
	1900	0.39	5.33	0.50	9.85	0.51	8.83	0.74	9.14
3	0100	0.36	5.82	0.53	8.26	0.62	8.53	0.93	8.83
	0700	0.85	5.69	0.78	9.48	0.77	9.48	1.13	8.26
	1300	0.47	7.53	0.77	9.48	0.89	9.14	1.39	7.11
	1900	0.82	9.14	0.74	8.00	0.82	7.76	1.30	8.53
4	0100	0.30	9.14	0.60	9.14	0.73	9.14	1.03	9.14
	0700	0.76	5.69	0.79	9.48	0.82	8.83	1.17	8.53
	1300	0.67	5.69	0.85	5.82	0.84	6.40	1.31	4.06
	1900	0.86	5.45	0.77	5.82	0.77	4.66		
5	0100	0.81	5.57	0.92	5.69	0.89	5.82		
	0700	1.26	6.74	1.02	6.24	1.02	6.74		
	1300	0.96	6.09	0.88	5.95	0.85	5.95		
	1900	0.84	5.82	0.77	5.95	0.73	5.82		
6	0100	0.48	5.22	0.50	18.29	0.52	9.14		
	0700	0.28	18.29	0.33	9.48	0.33	11.13		
	1300	0.14	9.14	0.19	16.00	0.24	9.85		
	1900	0.10	16.00	0.19	15.06	0.23	10.67		
7	0100	0.17	17.07	0.22	10.24	0.24	15.06		
	0700	0.25	16.00	0.26	17.07	0.28	8.83		
	1300	0.20	17.07	0.26	16.00	0.28	16.00		
	1900	0.29	5.95	0.28	15.06	0.30	16.00		
8	0100	0.15	16.00	0.22	15.06	0.24	15.06	Gage Inoperative	
	0700	0.20	9.14	0.21	14.22	0.23	9.14		
	1300	0.13	4.57	0.24	14.22	0.24	8.83		
	1900	0.17	15.06	0.22	14.22	0.26	8.53		
9	0100	0.16	17.07	0.27	8.83	0.24	8.26		
	0700	0.27	8.53	0.22	8.26	0.26	8.26		
	1300	0.13	17.07	0.29	16.00	0.26	8.26		
	1900	0.20	4.74	0.29	15.06	0.28	15.06		
10	0100	0.15	4.74	0.34	15.06	0.30	7.76		
	0700	1.76	6.56	1.60	6.56	1.62	6.74		
	1300	1.53	6.40	1.59	6.74	1.64	6.40		
	1900	1.18	7.53	1.27	7.31	1.34	7.31		
11	0100	0.95	9.48	1.11	9.14	1.09	8.83		
	0700	0.81	9.48	1.11	9.14	1.22	9.85		
	1300	0.89	9.85	1.14	10.67	1.11	10.24		
	1900	0.75	11.13	1.22	9.48	1.24	9.48		
12	0100	0.96	10.24	1.10	10.67	1.14	10.24		
	0700	0.56	8.53	0.91	11.64	0.90	11.13		
	1300	0.70	12.19	0.94	11.64	1.00	11.64	1.04	12.19
	1900	0.53	12.19	0.94	12.19	1.02	11.64	0.97	11.64
13	0100	0.71	11.64	0.82	11.64	0.85	11.13	0.89	11.64
	0700	0.40	4.92	0.72	11.64	0.77	11.13	0.83	10.67
	1300	0.59	4.74	0.62	11.13	0.68	10.67	0.77	9.85
	1900	0.29	4.49	0.59	11.64	0.60	11.64	0.65	11.64
14	0100	0.50	4.74	0.50	11.64	0.53	11.64	0.68	11.13
	0700	0.22	11.13	0.45	10.67	0.48	11.13	0.60	10.67
	1300	0.41	5.02	0.42	11.64	0.44	11.64	0.62	10.67
	1900	0.27	6.92	0.39	6.74	0.45	6.56	0.61	6.74
15	0100	0.98	5.12	0.92	5.12	0.93	5.02	1.11	5.02
	0700	0.78	5.82	0.94	5.95	0.86	5.82	1.22	7.11
	1300	0.60	6.09	0.66	6.24	0.61	6.40	0.79	6.40
	1900	0.30	5.45	0.35	7.53	0.37	6.74	0.49	7.31
16	0100	*	0.16	8.83	0.19	8.83	0.50	2.69	
	0700	0.27	2.88	0.41	2.61	0.23	3.24	0.68	3.61
	1300	0.51	5.69	0.72	5.45	0.73	5.69	1.11	5.33
	1900	0.91	6.74	0.90	7.11	0.88	6.92	1.07	7.11

* Electronic problems

(Continued)

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(Sheet 1 of 2)

Table 3: Wave Data

Dec 1991

Day	Hour	645		625		111		630	
		Baylor at 7+80	Hmo.m T.sec	Baylor at 18+60	Hmo.m T.sec	Pressure Gage	Hmo.m T.sec	Offshr Wvrdr	Hmo.m T.sec
17	0100	0.41	5.45	0.42	5.02	0.45	4.83	0.54	5.45
	0700	0.10	4.92	0.22	6.40	0.20	6.56	0.36	2.44
	1300	0.14	4.00	0.34	2.98	0.24	3.28	0.69	3.88
	1900	0.53	4.06	0.51	3.56	0.51	3.51	1.22	5.33
18	0100	0.19	4.06	0.34	7.11	0.38	6.92	1.01	4.74
	0700	0.12	8.00	0.23	7.76	0.32	7.53	*	*
	1300	0.41	3.88	0.70	4.27	0.63	4.13		
	1900	1.09	5.22	1.16	4.83	1.14	4.92	1.60	4.92
19	0100	1.23	6.40	1.58	6.56	1.78	6.56	2.35	6.56
	0700	1.70	6.92	2.01	6.92	2.05	6.74	2.88	7.31
	1300	0.97	6.56	1.94	6.40	1.99	6.92		
	1900	1.34	7.11	1.80	6.24	1.83	5.69		
20	0100	0.90	6.24	1.68	8.00	1.82	6.09		
	0700	1.40	6.56	1.38	7.53	1.41	6.56		
	1300	0.94	7.31	1.35	8.53	1.24	9.48		
	1900	0.93	6.92	0.94	9.85	1.06	9.85		
21	0100	0.60	6.24	0.75	9.85	0.75	10.24		
	0700	0.33	9.48	0.53	9.48	0.52	9.48		
	1300	0.17	9.85	0.28	9.85	0.35	9.48		
	1900	0.22	11.13	0.27	11.64	0.28	11.64		
22	0100	0.32	2.84	0.34	11.64	0.31	11.64		
	0700	1.29	6.56	1.24	5.95	1.13	6.56		
	1300	0.88	5.69	0.95	6.24	0.91	5.95		
	1900	0.84	5.69	0.73	7.11	0.72	6.74		
23	0100	0.34	6.09	0.41	6.74	0.44	6.40		
	0700	0.20	5.33	0.27	7.11	0.30	8.26		
	1300	0.16	9.48	0.29	8.83	0.28	8.83		
	1900	0.28	14.22	0.34	14.22	0.31	12.19		
24	0100	0.18	13.47	0.36	12.80	0.39	13.47		
	0700	1.26	4.20	1.29	4.20	1.17	4.41		
	1300	1.35	6.09	1.64	6.74	1.71	6.92		
	1900	1.34	6.40	1.33	6.40	1.35	6.40		
25	0100	1.09	7.11	1.19	12.19	1.30	13.47		
	0700	0.90	6.24	0.94	12.19	0.93	12.19		
	1300	0.71	5.82	0.72	11.64	0.80	12.19		Gage
	1900	0.46	5.69	0.73	6.24	0.80	6.40		Inoperative
26	0100	0.54	11.64	0.59	11.13	0.57	12.19		
	0700	0.29	3.88	0.58	11.13	0.55	11.13		
	1300	0.47	4.41	0.50	11.13	0.48	10.67		
	1900	0.21	3.77	0.42	10.67	0.43	10.67		
27	0100	0.61	5.33	0.58	5.33	0.55	5.33		
	0700	0.44	3.28	0.63	8.53	0.53	8.83		
	1300	1.10	4.66	1.03	4.74	0.96	4.74		
	1900	0.93	5.45	1.26	5.57	1.23	5.33		
28	0100	1.41	5.57	1.28	5.57	1.26	5.57		
	0700	0.89	5.82	1.28	5.95	1.26	6.09		
	1300	1.15	5.69	1.06	5.69	1.09	5.69		
	1900	0.75	5.12	0.96	5.33	0.92	5.12		
29	0100	0.90	6.40	0.99	6.56	1.04	6.56		
	0700	0.53	7.53	0.98	8.00	1.04	7.31		
	1300	0.81	8.00	0.94	7.53	1.00	8.00		
	1900	0.38	8.53	0.64	8.53	0.74	8.26		
30	0100	0.45	9.14	0.63	9.14	0.68	9.14		
	0700	0.17	9.85	0.48	10.24	0.58	9.48		
	1300	1.33	5.69	1.27	4.74	1.26	4.92		
	1900	1.22	5.95	1.67	6.09	1.73	5.95		
31	0100	1.50	7.76	1.87	7.53	1.91	7.76		
	0700	1.43	7.11	1.94	6.92	2.00	6.09		
	1300	1.27	10.67	2.04	6.92	2.13	10.67		
	1900	1.34	8.26	2.00	9.48	2.15	10.24		
Mean		0.64	7.49	0.79	8.88	0.80	8.41	0.97	7.46
Std dev		0.42	3.39	0.48	3.22	0.49	2.71	0.46	2.56

* Electronic problems

(Sheet 2 of 2)

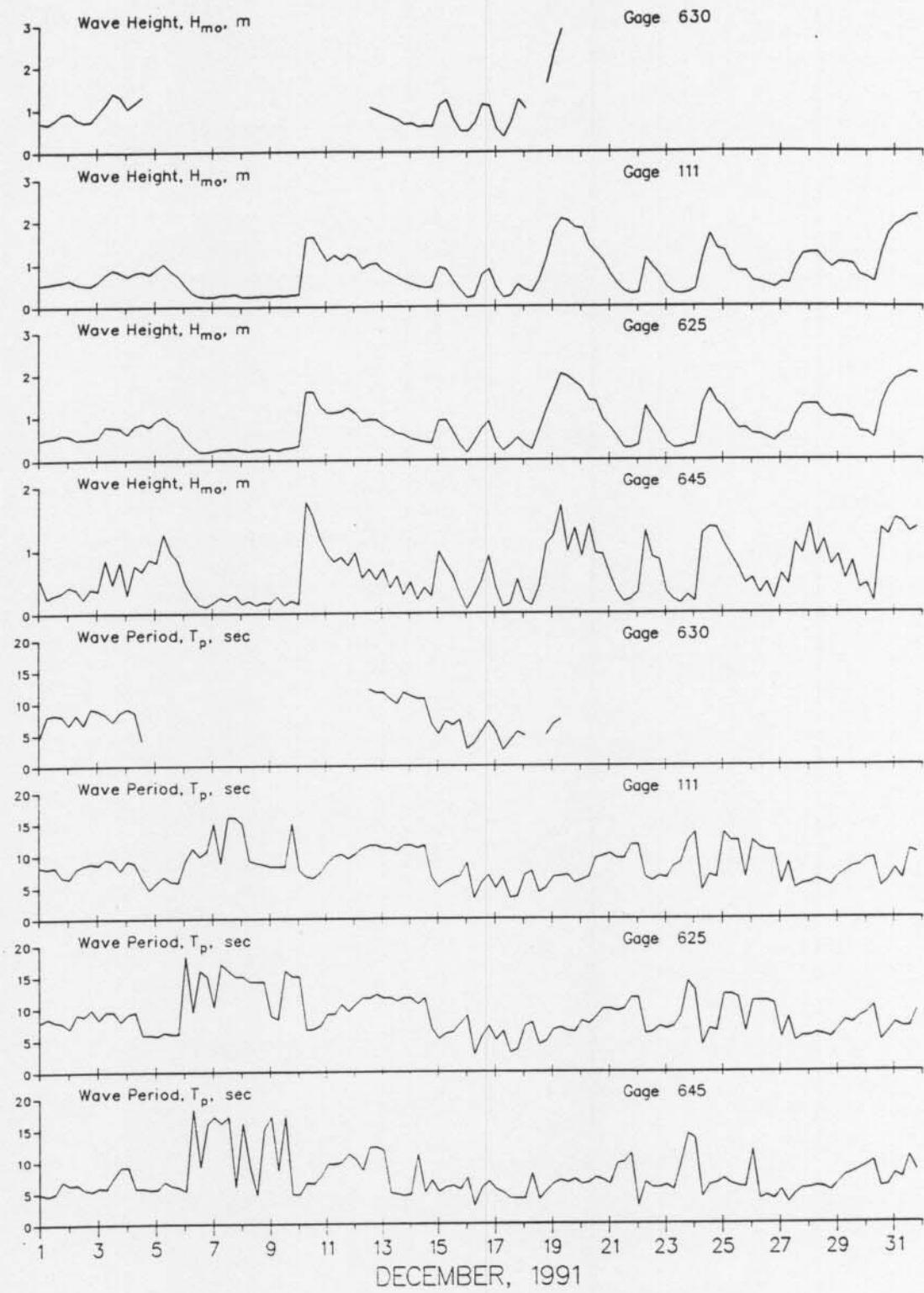


Figure 3. Time history of wave heights and periods

PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data
Dec 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements			Current Meter	
	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
1 0100-Along Cross Result								9	N
								4	on
								10	316
1 0700-Along Cross Result	27 11 29	N off 2	165	34 3 34	N off 346	no observation		6 2 6	N on 322
1 1300-Along Cross Result								14 8 16	N on 310
1 1900-Along Cross Result								9 5 10	N on 311
2 0100-Along Cross Result								10 10 14	N on 295
2 0700-Along Cross Result	11 9 14	N off 19	201	15 5 16	N off 357	South	42 S	3 5 6	N on 281
2 1300-Along Cross Result								8 6 10	N on 303
2 1900-Along Cross Result								1 4 4	S off 84
3 0100-Along Cross Result								0 5 5	
3 0700-Along Cross Result	32 10 33	N off 357	201	27 3 27	N off 346	South	61 S	2 2 3	N on 295
3 1300-Along Cross Result								23 9 25	N on 319
3 1900-Along Cross Result								6 7 9	N on 291
4 0100-Along Cross Result								3 9 9	N on 268
4 0700-Along Cross Result	61 0 61	S off 160	213	15 12 20	S off 121	North	15 N	18 5 19	S off 144
4 1300-Along Cross Result								17 4 17	S off 147
4 1900-Along Cross Result								20 7 21	S off 141
5 0100-Along Cross Result								10 1 10	S off 154
5 0700-Along Cross Result	23 0 23	S off 160	165	61 0 61	S off 160	North	44 N	3 3 4	S off 115
5 1300-Along Cross Result								8 3 9	S off 139
5 1900-Along Cross Result								3 3 4	S off 115

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Dec 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements				Current Meter		
	Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir
6 0100-Along Cross Result										15	N
										5	on
										16	322
6 0700-Along Cross Result	16	N			152	5	N off		0	22	N
	32	off				15				8	on
	36	43				16	52			23	320
6 1300-Along Cross Result										17	N
										6	on
										18	321
6 1900-Along Cross Result										4	N
										1	off
										4	354
7 0100-Along Cross Result										3	S
										2	off
										4	126
7 0700-Along Cross Result	20	N				7	N		6	N	
	8	off				4	off			1	on
	21	2				8	11			6	331
7 1300-Along Cross Result										4	N
										0	
										4	340
7 1900-Along Cross Result										5	N
										3	on
										6	309
8 0100-Along Cross Result										1	N
										2	on
										2	277
8 0700-Along Cross Result	9	N				0				9	N
	5	off				2	off			1	on
	10	11				2	70			9	334
8 1300-Along Cross Result										5	N
										0	
										5	340
8 1900-Along Cross Result										6	N
										3	on
										7	313
9 0100-Along Cross Result										1	N
										1	off
										1	25
9 0700-Along Cross Result	15	N				6	N		11	N	
	14	off				14	off			4	on
	21	22				15	47			12	320
9 1300-Along Cross Result										3	N
										4	on
										5	287
9 1900-Along Cross Result										2	N
										1	on
										2	313
10 0100-Along Cross Result										5	S
										0	
										5	160
10 0700-Along Cross Result	20	S				122	S			35	S
	6	on				0				11	off
	21	177				122	160			37	143
10 1300-Along Cross Result										40	S
										14	off
										42	141
10 1900-Along Cross Result										25	S
										9	off
										27	140

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Dec 1991

Day	Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter				
		Dye at (579 m) (surface)	Speed	Dir	Dye at Mid-Surf Zone (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	
11 0100-Along Cross Result											21	S	
											8	off	
											22	139	
11 0700-Along Cross Result	17 5 18	S on 177			51 0 51	S 160			20	S	12 4 13	S off 142	
11 1300-Along Cross Result											18 11 21	S off 129	
11 1900-Along Cross Result											12 5 13	S off 137	
12 0100-Along Cross Result											14 8 16	S off 130	
12 0700-Along Cross Result	0 5 5		on 250		177	0 8 8		on 250		North	0	4 1 4	S off 146
12 1300-Along Cross Result											6 5 8	S off 120	
12 1900-Along Cross Result											6 4 7	S off 126	
13 0100-Along Cross Result											16 6 17	S off 139	
13 0700-Along Cross Result	23 3	N off			152	22 2	N off		45	N	2 1 2	S off 133	
13 1300-Along Cross Result	23	349				22	346				5 5 7	N on 295	
13 1900-Along Cross Result											8 6 10	N on 303	
14 0100-Along Cross Result											6 5 8	N on 300	
14 0700-Along Cross Result	25 15 30	N off 11			148	30 18 36	N off 11		36	N	12 6 13	N on 313	
14 1300-Along Cross Result											14 8 16	N on 310	
14 1900-Along Cross Result											10 7 12	N on 305	
15 0100-Along Cross Result											11 4 12	S off 140	
15 0700-Along Cross Result	16 14 22	S off 118			177	61 9 62	S off 151		43	S	9 2 9	S off 147	
15 1300-Along Cross Result											10 5 11	N on 313	
15 1900-Along Cross Result											14 4 15	N on 324	

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Dec 1991

Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements			Current Meter	
	Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519
Day	Speed	Dir							
16 0100-Along Cross Result									19 6 20
16 0700-Along Cross Result	30 0	S 160	165	41 12 42	S on 177	North	46	S	N off 25
16 1300-Along Cross Result									11 3 11
16 1900-Along Cross Result									145 S off 149
17 0100-Along Cross Result									10 2 10
17 0700-Along Cross Result	20 6 21	N off 357	165	14 4 14	N off 357	South	5	N	1 0 0
17 1300-Along Cross Result									14 4 15
17 1900-Along Cross Result									16 5 17
18 0100-Along Cross Result									17 N on 321
18 0700-Along Cross Result	21 3 21	S on 169	140	30 12 33	S off 138	North	37	S	2 1 2
18 1300-Along Cross Result									14 4 15
18 1900-Along Cross Result									30 11 32
19 0100-Along Cross Result									41 S off 145
19 0700-Along Cross Result	55 0 55	S 160	274	30 9 32	S off 143	no observation			46 S off 140
19 1300-Along Cross Result									50 17 53
19 1900-Along Cross Result									47 18 50
20 0100-Along Cross Result									26 S off 139
20 0700-Along Cross Result	23 0 23	S 160	165	61 0 61	S 160	no observation			26 10 28
20 1300-Along Cross Result									16 4 16
20 1900-Along Cross Result									16 6 17
									off off 139 S off 146 S off 139

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Dec 1991

Alongshore Cross-shore Resultant Time	Pier Measurements				Beach Measurements			Current Meter	
	Dye at (579 m) (surface)	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore Depth - 5.6m (NGVD) ID #519
Day	Speed	Dir							
21 0100-Along Cross Result								9	S
								4	off
								10	136
21 0700-Along Cross Result	10 13 17	N off 33	144	9 7 11	N off 17	South	15	N	
								8	N
								7	on
								11	299
21 1300-Along Cross Result								14	N
								8	on
								16	310
21 1900-Along Cross Result								3	N
								4	on
								5	287
22 0100-Along Cross Result								6	S
								2	off
								6	142
22 0700-Along Cross Result	20 6 21	S off 143	156	23 0 23	S 0 160	North	36	S	
								2	S
								2	off
								3	115
22 1300-Along Cross Result								6	S
								2	off
								6	142
22 1900-Along Cross Result								4	N
								3	on
								5	303
23 0100-Along Cross Result								4	N
								4	on
								6	295
23 0700-Along Cross Result	6 5 8	N off 17	128	5 2 5	N off 7	South	11	N	
								11	N
								6	on
								13	311
23 1300-Along Cross Result								5	N
								5	on
								7	295
23 1900-Along Cross Result								6	N
								5	on
								8	300
24 0100-Along Cross Result								2	S
								3	on
								4	216
24 0700-Along Cross Result	76 8 77	S on 166	152	87 0 87	S 0 160	North	67	S	
								14	S
								5	off
								15	140
24 1300-Along Cross Result								48	S
								17	off
								51	140
24 1900-Along Cross Result								25	S
								7	off
								26	144
25 0100-Along Cross Result								23	S
								7	off
								24	143
25 0700-Along Cross Result	6 5 8	S off 118	140	5 2 5	S off 143	North	50	S	
								9	S
								2	off
								9	147
25 1300-Along Cross Result								8	S
								4	off
								9	133
25 1900-Along Cross Result								9	S
								2	off
								9	147

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Continued)
Dec 1991

Day	Time	Pier Measurements				Beach Measurements			Current Meter			
		Dye at (579 m) Speed	Dye at (surface) Dir	Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	0.9 km Offshore Depth -5.6m (NGVD) ID #519	Speed	Dir
26	0100-Along Cross Result										13	S
											5	off
											14	139
26	0700-Along Cross Result	5	S on	140	5	S off	North	11	S	1	S	
		2			1			0				
		5	182		5	143				1	160	
26	1300-Along Cross Result									9	S	
										7	off	
										11	122	
26	1900-Along Cross Result									8	S	
										1	off	
										8	153	
27	0100-Along Cross Result									10	S	
										5	off	
										11	133	
27	0700-Along Cross Result	20	S on	152	44	S	North	43	S	9	S	
		6			0			3				
		21	177		49	160				9	142	
27	1300-Along Cross Result									19	S	
										6	off	
										20	142	
27	1900-Along Cross Result									19	S	
										7	off	
										20	140	
28	0100-Along Cross Result									18	S	
										7	off	
										19	139	
28	0700-Along Cross Result	9	S on	189	55	S	North	38	S	15	S	
		6			0					6	off	
		11	191		55	160				16	138	
28	1300-Along Cross Result									13	S	
										5	off	
										14	139	
28	1900-Along Cross Result									8	S	
										4	off	
										9	133	
29	0100-Along Cross Result									6	S	
										0		
										6	160	
29	0700-Along Cross Result	20	N		0					0		
		6	off		2	off				1	on	
		21	357		2	70	South	61	N	1	250	
29	1300-Along Cross Result									12	N	
										7	on	
										14	310	
29	1900-Along Cross Result									6	N	
										8	on	
										10	287	
30	0100-Along Cross Result									2	N	
										7	on	
										7	266	
30	0700-Along Cross Result	18	S	152	19	S	North	23	S	14	S	
		2	off		3	off				6	off	
		19	154		19	151				15	137	
30	1300-Along Cross Result									25	S	
										11	off	
										27	136	
30	1900-Along Cross Result									38	S	
										14	off	
										40	140	

KEY = All speeds in cm/sec

N = Northward, Shore parallel

S = Southward, Shore parallel

on = onshore off = offshore

Table 4: Current Data (Concluded)
Dec 1991

Alongshore Cross-shore Resultant Time Day	Pier Measurements				Beach Measurements (500m Updrift)				Current Meter	
	Dye at (579 m) (surface)	Dye at Mid-Surf Zone (surface)	Distance from Baseline	Speed	Dye 12m offshore (surface)	Location	Speed	Dir	0.9 km Offshore / Depth -5.6m (NGVD) ID #519	
	Speed	Dir	(m)	Dir			Speed	Dir	Speed	Dir
31 0100-Along Cross Result									34	S
									12	off
									36	141
31 0700-Along Cross Result	47	S		102	S		67	S	42	S
	0		189	0		North			19	off
	47	160		102	160				46	136
31 1300-Along Cross Result									37	S
									14	off
									40	139
31 1900-Along Cross Result									41	S
									18	off
									45	136

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
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 on = onshore off = offshore

PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Dec 1991

Day	Time	Wave Approach		Radar Wave Angle deg from True N	Width of Surf Zone.m	Water Characteristics at Pier End		
		Primary	Secondary			Temp., C	Density g/cc	Secchi Vis., m
1	0900	90	125		53	13.9	1.0244	0.3
2	1010	120	150		195	14.5	1.0247	1.2
3	1445	120	150		195	15.5	1.0246	1.5
4	0910	25		90	146	15.0	1.0250	0.6
5	0945	20		40	171	13.3	1.0250	7.6
6	1115	none visible			34	12.8	1.0248	0.6
7	0850	80			16	12.8	1.0250	2.1
8	0945	90	140		19	13.3	1.0252	1.8
9	1050	145			10	13.3	1.0248	1.5
10	0900	30	145	50	171	12.8	1.0251	0.6
11	0909	60	35	45	157	12.2	1.0249	1.2
12	0850	75		80	143	12.8	1.0248	2.4
13	0900	115	150		187	13.2	1.0246	1.8
14	0914	120	150		9	13.3	1.0246	1.2
15	0945	25			22	12.8	1.0252	0.9
16	0848	10		55	113	11.7	1.0250	1.2
17	0930	150	125		9	11.2	1.0250	1.5
18	1300	35		inoperative	9	11.7	1.0252	1.2
19	1015	30		45	216	8.9	1.0254	0.6
20	1122	45		65	167	8.3	1.0247	0.6
21	0905	75	135	75	13	8.9	1.0247	0.9
22	0930	40		35	32	10.0	1.0248	1.5
23	0930	none visible			5	10.0	1.0250	1.2
24	0850	40		40	107	10.6	1.0250	0.3
25	0855	40	65		24	10.0	1.0248	0.3
26	0919	65		60	9	10.0	1.0248	0.9
27	0810	30	60	65	27	10.0	1.0246	1.2
28	0930	20		30	132	10.0	1.0242	1.8
29	0925	100			185	10.0	1.0243	1.2
30	0938	20			15	10.0	1.0246	0.6
31	0755	60		60	171	8.9	1.0240	0.3

PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

FRF Tide Heights

Dec 1991

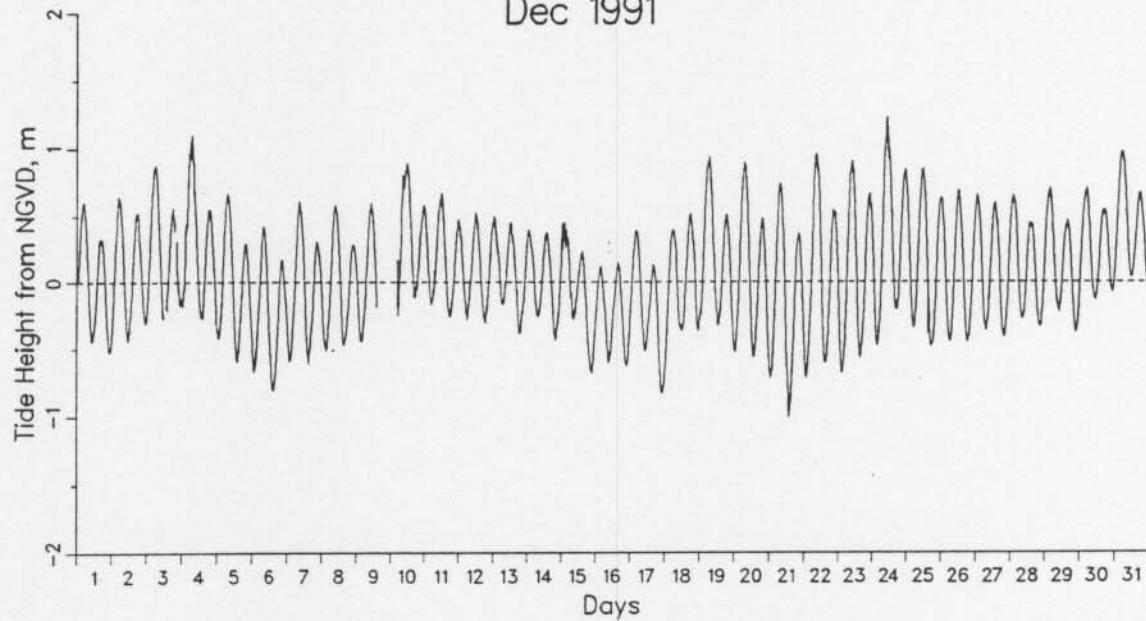


Figure 4. Water level time history

Monthly Water Levels, m NGVD

Extreme Low = -1.01 on day 21 at 1254 EST
Extreme High = 1.23 on day 24 at 906 EST

Monthly Mean = 0.07

Mean Low = -0.43

Mean High = 0.57

Mean Range = 1.01

Table 6: Water Levels.m NGVD

Dec 1991					
Day	Mid-Cycle Time	Low	High	Mean	Range
1	654	-0.44	0.60	0.08	1.04
1	1919	-0.52	0.34	-0.08	0.86
2	744	-0.44	0.65	0.11	1.09
2	2009	-0.31	0.52	0.10	0.83
3	834				
3	2100				
4	925	-0.27	1.10	0.38	1.37
4	2150	-0.42	0.55	0.07	0.98
5	1015	-0.59	0.67	0.06	1.26
5	2240	-0.67	0.30	-0.17	0.97
6	1106	-0.81	0.43	-0.22	1.23
6	2331	-0.59	0.17	-0.20	0.77
7	1156	-0.61	0.61	0.01	1.22
8	21	-0.51	0.31	-0.09	0.82
8	1246	-0.48	0.58	0.04	1.06
9	112	-0.45	0.28	-0.05	0.73
9	1337				
10	202				
10	1427	-0.12	0.90	0.38	1.02
11	252	-0.17	0.58	0.21	0.75
11	1518	-0.26	0.67	0.17	0.93
12	343	-0.28	0.48	0.11	0.76
12	1608	-0.30	0.53	0.10	0.84
13	433	-0.17	0.50	0.16	0.67
13	1658	-0.39	0.45	0.02	0.84
14	524	-0.26	0.40	0.07	0.66
14	1749	-0.44	0.38	-0.01	0.82
15	614	-0.28	0.46	0.08	0.73
15	1839	-0.68	0.23	-0.25	0.91
16	704	-0.61	0.12	-0.22	0.73
16	1929	-0.63	0.15	-0.21	0.78
17	755	-0.51	0.40	-0.07	0.91
17	2020	-0.83	0.13	-0.34	0.96
18	845	-0.37	0.39	0.01	0.76
18	2110	-0.37	0.56	0.10	0.93
19	935	-0.33	0.94	0.28	1.26
19	2201	-0.52	0.51	0.03	1.03
20	1026	-0.56	0.90	0.15	1.46
20	2251	-0.72	0.48	-0.10	1.20
21	1116	-1.01	0.74	-0.11	1.75
21	2341	-0.71	0.41	-0.12	1.12
22	1207	-0.61	0.96	0.16	1.57
23	32	-0.68	0.54	-0.03	1.22
23	1257	-0.57	0.91	0.16	1.48
24	122	-0.48	0.67	0.14	1.15
24	1347	-0.21	1.23	0.45	1.44
25	213	-0.35	0.84	0.26	1.19
25	1438	-0.48	0.85	0.15	1.33
26	303	-0.45	0.64	0.10	1.08
26	1528	-0.45	0.69	0.10	1.14
27	353	-0.36	0.66	0.15	1.02
27	1619	-0.41	0.60	0.09	1.01
28	444	-0.28	0.66	0.18	0.93
28	1709	-0.33	0.45	0.07	0.78
29	534	-0.23	0.71	0.24	0.94
29	1759	-0.37	0.46	0.07	0.84
30	625	-0.13	0.71	0.27	0.84
30	1850	-0.08	0.55	0.26	0.62
31	715	0.04	0.98	0.51	0.94
31	1940	-0.03	0.68	0.34	0.71

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking electronic theodolite, distance meter in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in November and the two surveys done in December on profile line 188, located 517 m south of the pier. The nearshore bar (240 - 400 m) migrated 30 m shoreward while a small berm was rebuilt on the beach face (120 m). Only minor changes are visible on the remainder of the profile.

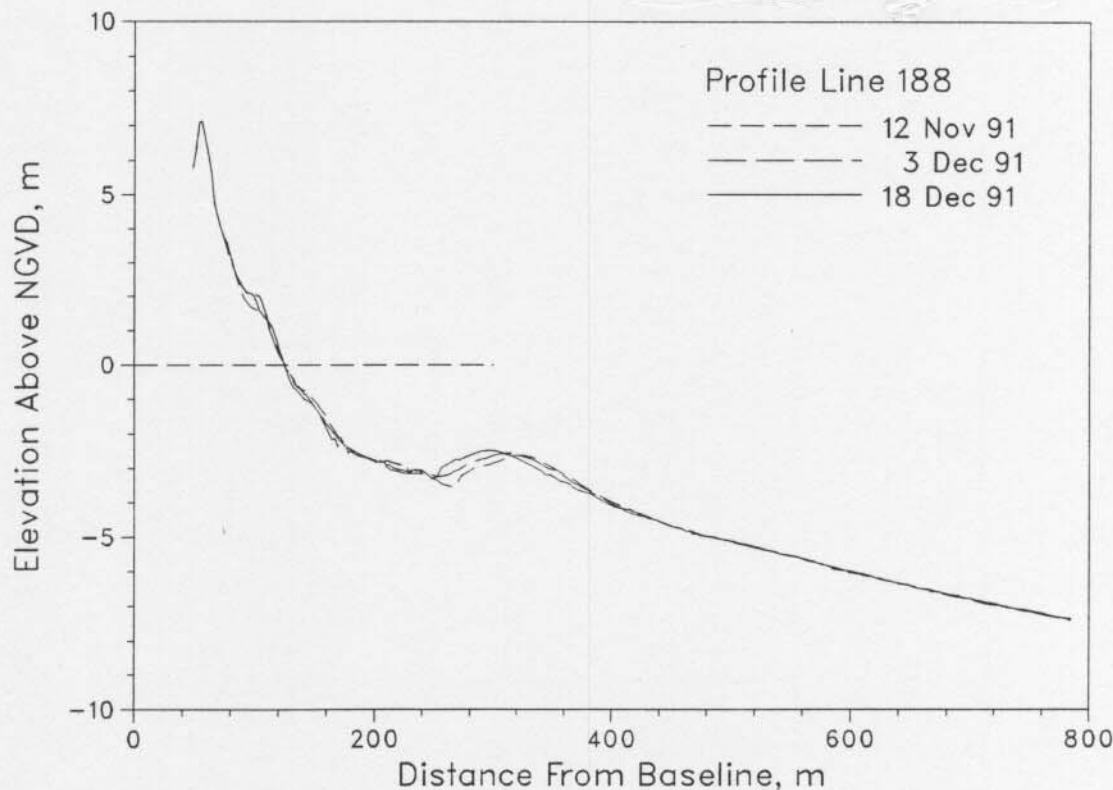


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1991.

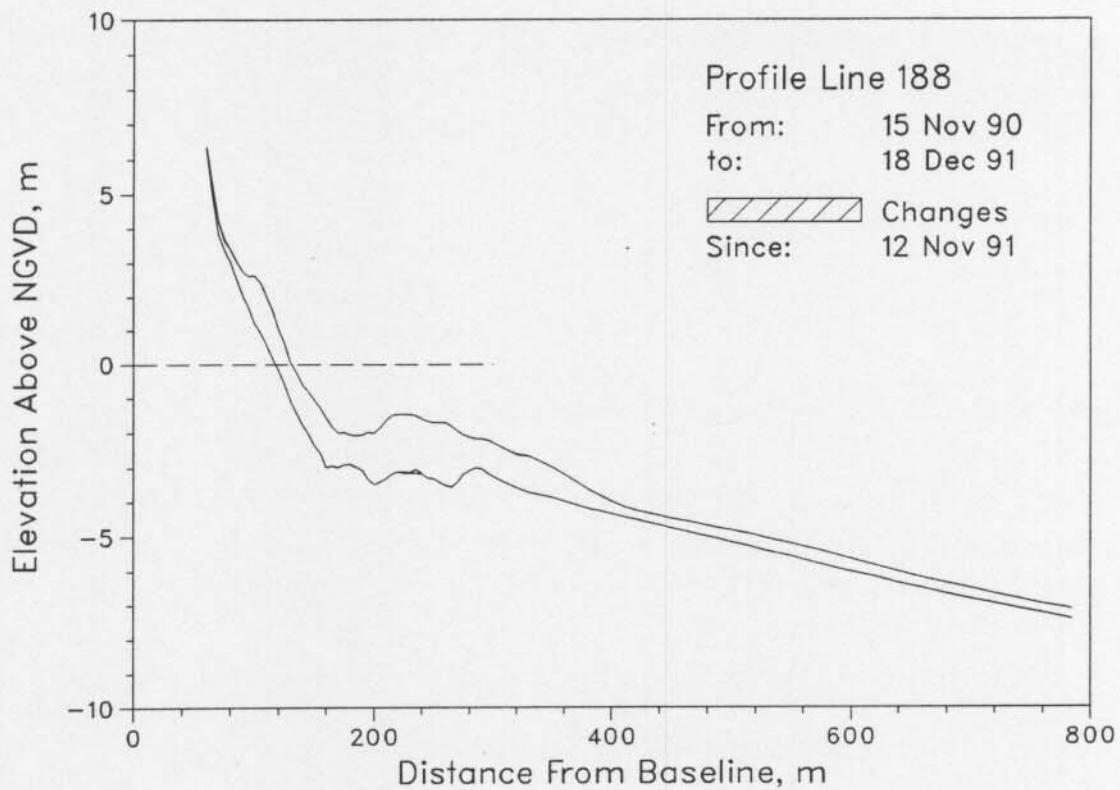


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the most recent bathymetric survey on 18 December. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

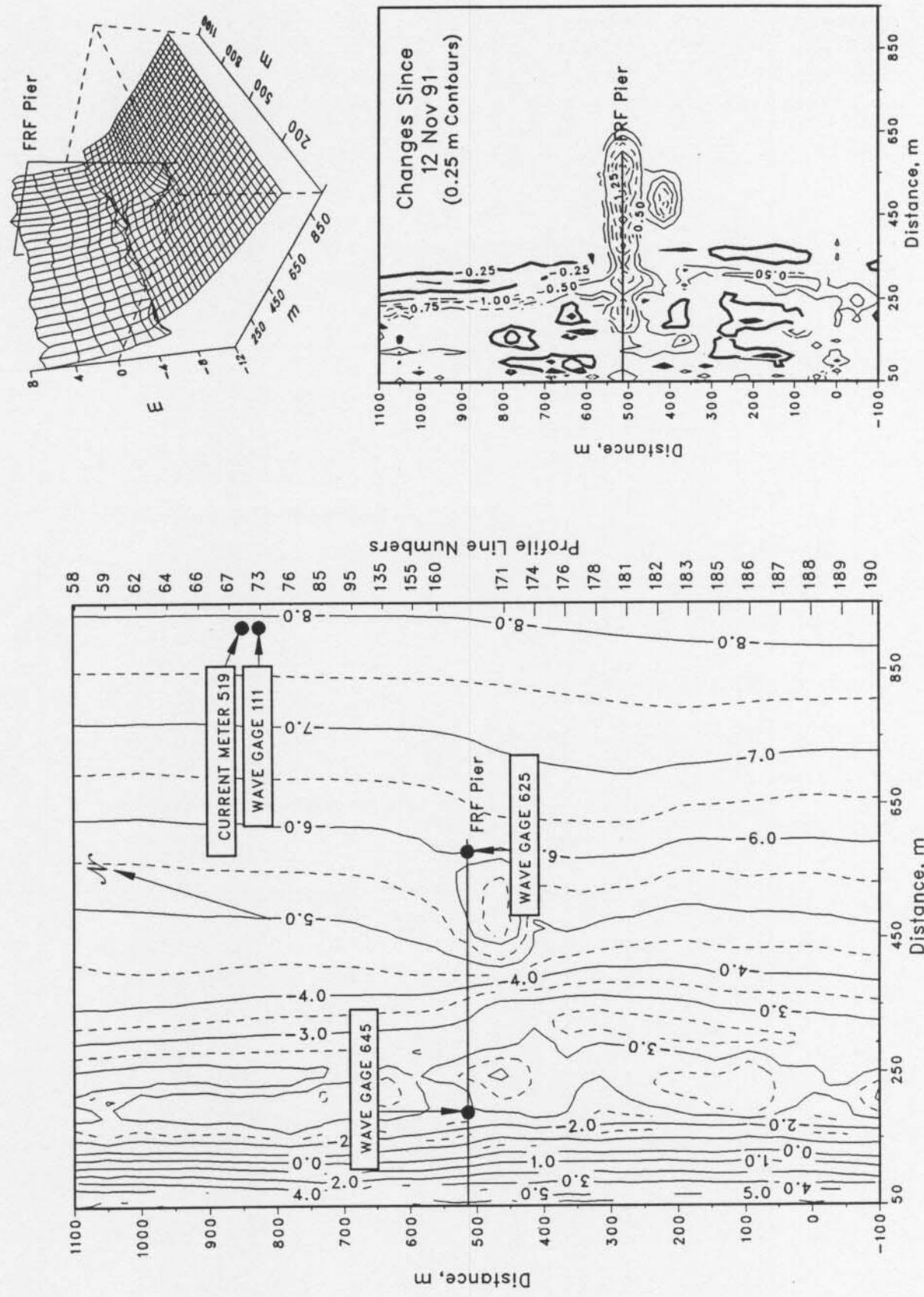


Figure 7. FRF bathymetry 18 Dec 91 depths relative to NGVD

PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
19 Dec (0700)	19 Dec (1216)
31 Dec (0242)	31 Dec (2342)

B. Storm Synopsis.

19 December - A strong high pressure system centered over the Great Lakes briefly generated storm waves at the FRF on 19 December. The peak wind speed (from north-northwest) which surpassed 15 m/s was recorded at 1216 EST on 19 December. The maximum H_{mo} (at gage 625) of 2.18 m ($T_p = 7.31$ sec) occurred several hours earlier at 1034 EST.

31 December - Another strong high pressure system centered over the Great Lakes again briefly generated storm waves at the FRF on 31 December. The peak wind speed (from northeast) which exceeded 12 m/s was recorded at 0734 EST on 31 December. The maximum H_{mo} (at gage 625) of 2.07 m ($T_p = 10.67$ sec) occurred several hours later at 1742 EST.

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